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TITLE: ELEVATION OF SURFICIAL SEDIMENT/BASALT CONTACT AND SOIL VOLUMES ABOVE PITS AND TRENCHES IN THE SUBSURFACE DISPOSAL AREA, IDAHO NATIONAL ENGINEERING LABORATORY

SUMMARY

The summary briefly defines the problem or activity to be addressed in the EDF, gives a summary of the activities performed in addressing the problem and states the conclusions, recommendations, or results arrived at from this task.

Statistical surface generation techniques were used to construct a contour map of the surficial sediment/basalt contact and to determine soil volumes within pits and trenches in the SDA. Plan view drawings, cross-sections, and tables are used to present this information. This data is presented to provide a data base for future remedial actions at this site. Approximately 1400 elevation data points from published and unpublished reports, maps, and surveyors notes were compiled to generate this report.

The lowest elevation of the surficial sediment/basalt contact is 4970 ft and the greatest is land surface at 5015 ft. In general, an east-west trending depression exists in the central portion of the SDA and bounded by areas of basalt closer to land surface to the north and south.

The trench soil volumes were calculated by grouping close-spaced trenches together and determining the volume of this area. Therefore, these volumes are overestimated due to the inclusion of trench walls (separating each trench) and waste within the trenches were contained in the calculations. The resulting calculations for all trench areas yielded a volume of 16.7 x 10^6 cubic feet. This number represents the soil volume from land surface to the top of the basalt for all the trench areas.

The total volume of soil for all pits is 15.4 x 10^6 cubic feet, including the area obtained by waste. The volume of Pad A, from land surface to the top of the mound or hill, is approximately 1.2 x 10^6 cubic feet. These areas, as well as the trenches, include the volume of buried waste presently at these locations.

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	LITCO Review Date	LITCO Approval Date

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1.0 INTRODUCTION

The Radioactive Waste Management Complex (RWMC) is located in the southwest section of the Idaho National Engineering Laboratory (INEL) (Figure 1). It was established in 1952 as a disposal site for solid, low-level waste generated by what was then the National Reactor Testing Station. The RWMC presently comprises the Subsurface Disposal Area (SDA) and the Transuranic Storage Area (TSA). The TSA was established in 1970 for storage of waste contaminated with greater than 10 nCi/g transuranic (TRU) radionuclide activity.

The SDA is a fenced area which encompasses 96.8 acres of land in the western part of the RWMC. Included in the SDA are pits, trenches, soil vault rows, and Pad A. The SDA contains low-level and TRU waste as well as waste that could pose nonradiological hazards. Complete tables and listings of waste buried or stored at the RWMC can be found in Vigil, 1989.

This report was generated, in part, to 1) update results in a report by Hubbell (1993) in which a contour map of the surficial sediment/basalt contact within the SDA was presented, and 2) to determine soil volumes within and above pits and trenches. Soil vault rows and wells have been installed at the SDA since Hubbell's (1993) report and data from these locations were used to better define the surficial sediment/basalt contact.

1.1 Purpose and Scope

The purpose of this investigation is to update contour maps of the surficial sediment/basalt contact at the SDA and to determine soil volumes above the pits and trenches. Statistical surface generation techniques available in Arc/INFO, the standard geographic information system (GIS) in use at the INEL, was helpful in determining these data needs. This report builds upon work presented by Hubbell (1993) in which 15 published reports and unpublished drawings and documents were used to determine the depth (elevation) of basalt at the SDA. From these drawings, contours of the sediment/basalt contact and the average depth, minimum and maximum depth, soil volume above each pit ana trench, and cross-sections are used to present this information.

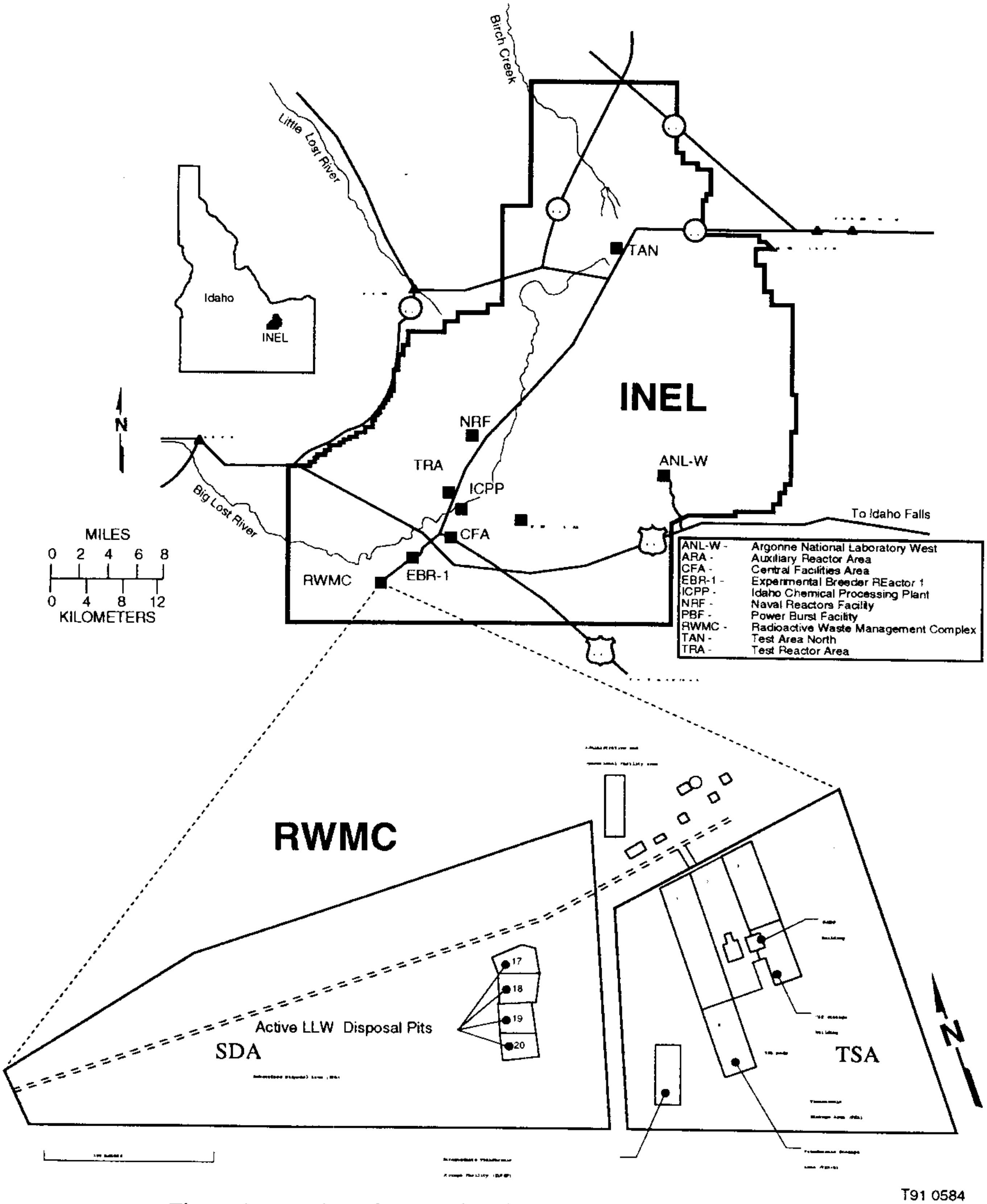


Figure 1: Location of the Radioactive Waste Management Complex, INEL.

This investigation also focuses on the locations of pits and trenches. Previous investigations (Yokuda, 1992 and Carpenter, 1992) indicate there are significant inaccuracies concerning trench locations with comparison to historical data. In some areas geophysical data indicate that the historical data poorly represent the actual location of the buried waste. Therefore, the estimates of soil volumes above the pits and trenches are considered to be overestimated. Hence, the cost of soil removal and disposal will also be significantly overestimated.

1.2 Approach

For this report, data on depth of basalt at the SDA were compiled from 4 sources including one published report and 3 unpublished drawings and documents. Depth to basalt, from the unpublished sources, was taken from geologist and geophysical logs. Coordinates, including northings, eastings, and basalt elevations were input into the Environmental Restoration Information System (ERIS) using the INEL coordinate system. The most recent (1995) map illustrating the land surface contour elevations were obtained from the ERIS data base. Appendix A contains a copy of the data base used in the Hubbell (1993) report and the additional data compiled since 1993. Both data sets also contain the reference as to the source of information.

Data for pit and trench locations were gathered from documents based on historical data (Yokuda, 1992) and geophysical data (Carpenter, 1992). The coordinates for pit and trench locations, including length and width were taken from Carpenter (1992). Together with Carpenter's (1992) data and the basalt and land surface contour maps of the SDA the soil volume of each pit and trench "network" was calculated. Based on the available data there is considerable uncertainty with reference to individual trench locations. Therefore, several trenches were combined into a "network" or block of trenches for the purpose of calculating soil volumes. The soil volume was calculated by combining trench "networks" together and estimating the volume for the entire area.

2.0 DATA SOURCES

Unpublished data from soil vault borings were digitized to obtain the northings and eastings. These soil vault borings were located along soil vault rows 17, 18, and 20, which were installed during the period 1991 through 1994. Other unpublished data included locations of wells (neutron access holes and vapor vacuum extraction wells). The northings, eastings, and land surface elevations for these wells were input directly into the data base from survey notes by Sutherlin (1995).

The individual soil vaults are 1.5 to 5 ft diameter cylinders which are buried in the surficial sediments. Auger holes are drilled to the top of the basalt, the depth recorded, at least two feet of sediment backfilled in the hole and then the vault placed in the hole. These vaults are installed along rows at 4 to 20 ft intervals. Their locations are measured in the field from the surveyed end markers. Data were obtained from records at the RWMC which contain the distance from a surveyed end marker and the depth to basalt from land surface.

Twenty-four neutron access wells were installed throughout the SDA in 1994. The location, land surface elevation, and the depth to basalt were recorded in a report by Bishop (1994) for 18 of these wells. The additional 6 well locations are not published. These locations were surveyed by Sutherlin (1994). The data was input directly into the data base from the survey notes.

The depth to basalt was taken from the geologist log for the neutron access wells. These depths were subtracted from the surveyed land surface elevation to obtain a basalt elevation.

Other soil vault boring data (prior to 1982) is on record but could not be located within the time frame of this report. Approximately 600 soil vault borings were completed prior to 1992. From these 600 locations only 360 were recovered by Hubbell (1993) for soil vault rows 9-20. The remaining data (240 locations) were sent to record storage in Seattle, Washington.

Data from 18 basalt outcrop locations, monitoring wells, neutron access boreholes, and test wells were incorporated into the data base to satisfy boundary conditions around the SDA. Most of these wells are located within 100 ft or less of the SDA perimeter. The northing, easting, land surface elevation, and depth to basalt was obtained from each of these wells. The inclusion of these data (control) points provide information outside of the SDA thus, allowing more accurate contour lines to be drawn near the SDA perimeter.

Pit and trench locations were obtained from historical records (Yokuda, 1992) and a geophysical survey conducted by Carpenter (1992). Several Soil Vault row locations were also reported in Carpenter's (1992) geophysical study.

2.1 Estimated Accuracy of Data

The relative accuracy of the various data sets have been estimated for the northing and easting coordinates and elevation. Locations which were surveyed have the best accuracy. Data presented in Appendix A contains a column labeled "Reference Number" that corresponds to the appropriate reference from which the data was obtained. This data is combined with the data Hubbell (1993) assembled to provide a complete reference.

Northing and easting coordinates, land surface elevations, and basalt depth for 18 neutron access holes were obtained from Bishop (1994). These well locations were surveyed using the Global Positioning System (GPS). The accuracy of this system is reported at 1 cm for horizontal location and 2 cm for vertical positioning (Beard, 1995).

Six neutron access holes were surveyed by Sutherlin (1995). These surveyed sites have an accuracy of 0.1 ft or better.

The most recent soil vault locations, included in this report were installed in soil vault rows 17 through 20. Yokuda (1992) estimated the accuracy of the surveyed markers for these soil vault rows. The ends of rows 17 through 20 were surveyed in 1991 and are probably accurate to within 0.1 ft. The locations of individual soil vaults were measured relative to these end markers and were probably measured within a foot of the true location. The location of soil vault row 17 is well supported by the geophysical data (Carpenter, 1992). However, the location of soil vault rows 18 through 20 were not determined using geophysical data.

Historical records for pit and trench locations were gathered from Environmental Restoration Information System (ERIS) data base and Yokuda (1992). Yokuda's (1992) report provides a thorough list, along with documentation on how each coordinate was determined, and the error associated with each coordinate.

Geophysical survey data (Carpenter, 1992) was used in order to demonstrate the inconsistences with the historical records and to directly tie the locations of the buried waste to physical measurements. Approximately two-thirds of the SDA was surveyed during Carpenter's (1992) investigation. Therefore, the remaining one-third of the pit and trench location data came from historical records only.

3.0 METHODOLOGY

The general approach for this study is to calculate the actual surface as a set of gridded values, calculate the best estimate of the bedrock surface as a set of gridded values, and then use map algebra (a derivative of matrix algebra, see Tomlin, 1990) to perform the calculations.

An accurate result for these calculations depend upon; a well chosen grid cell size, and accurate elevation surfaces of the land surface and top of the basalt. The grid cell size is essentially infinitely adjustable, depending only upon the speed and capacity of the computer performing the calculations, and can be adjusted to the expected accuracy of the elevation surfaces.

3.1 Grid Cell Size Determination

The land surface topography is derived from elevation contours collected by aerial survey, at a scale of 1:2000. Nominally, this translates to approximately plus or minus two feet at any surface point horizontally. Elevation is a derivative of horizontal control accuracy, but for relatively flat surfaces (like the SDA) the elevation accuracy is better than plus or minus one foot. This accuracy estimate is conservative, but the surface of the SDA changes regularly due to engineering activities, and so is probably representative.

The basalt surface is computed from approximately 1400 basalt elevation measurements (Figure 2). No record of vertical measurement accuracy for these points is available, but we can assume, given the small depths to basalt from land surface, most points have a vertical accuracy within plus or minus one foot. Considering a worst case (assuming a maximum error of the soil surface and a maximum error of basalt depth measurements) a single sample may be plus or minus two feet in error in the vertical direction. Therefore, the smallest grid cell size to be considered is two feet square (since the software always assumes square grid cells).

An additional error can be introduced due to the inaccuracy of the pit and trench locations before calculating the volumes. The boundary files (locations of the pit and trench boundaries) determined by this method were converted to Arc/INFO format and georeferenced (using State Base Plane East projection) so that the resulting polygon data set could be used with the computed grids.

3.2 Sediment/Basalt Contact Determination

Several geostatistical methods were tried in order to generate the sediment/basalt contact surface. Initially, the subsurface generation concentrated on geostatistical kriging techniques to determine the most realistic basalt surface. The data set used (Figure 2 and Appendix A) is very dense in select locations (for instance, the Soil Vault rows in the middle of the SDA were separated by an average of four feet), and very sparse in other locations (the southwest portion of the SDA). The complete data set introduced statistical anomalies for all kriging methods used: spherical, linear, circular, gaussian, and universal interpolation techniques (Royle et al, 1981). See Appendix B for examples of statistical anomalies generated when using the above kriging methods.

Figure 3 illustrates the sediment/basalt contact surface assembled using conventional splining techniques. The sediment/basalt contact is also illustrated in cross-sections (Figures 4 through 6). The splining method is best representative of the data set because it is not a statistical average, but includes the actual values of each data point. The results of this surface have been "hillshaded" to facilitate visualization. Figure 7 is a contour map constructed from the splining technique grid. Data points were incorporated into the data base to satisfy boundary conditions around the SDA. Most of these are located within 100 ft or less of the SDA perimeter. The inclusion of these data (control) points provide information outside of the SDA thus, allowing more accurate contour lines to be drawn near the SDA perimeter.

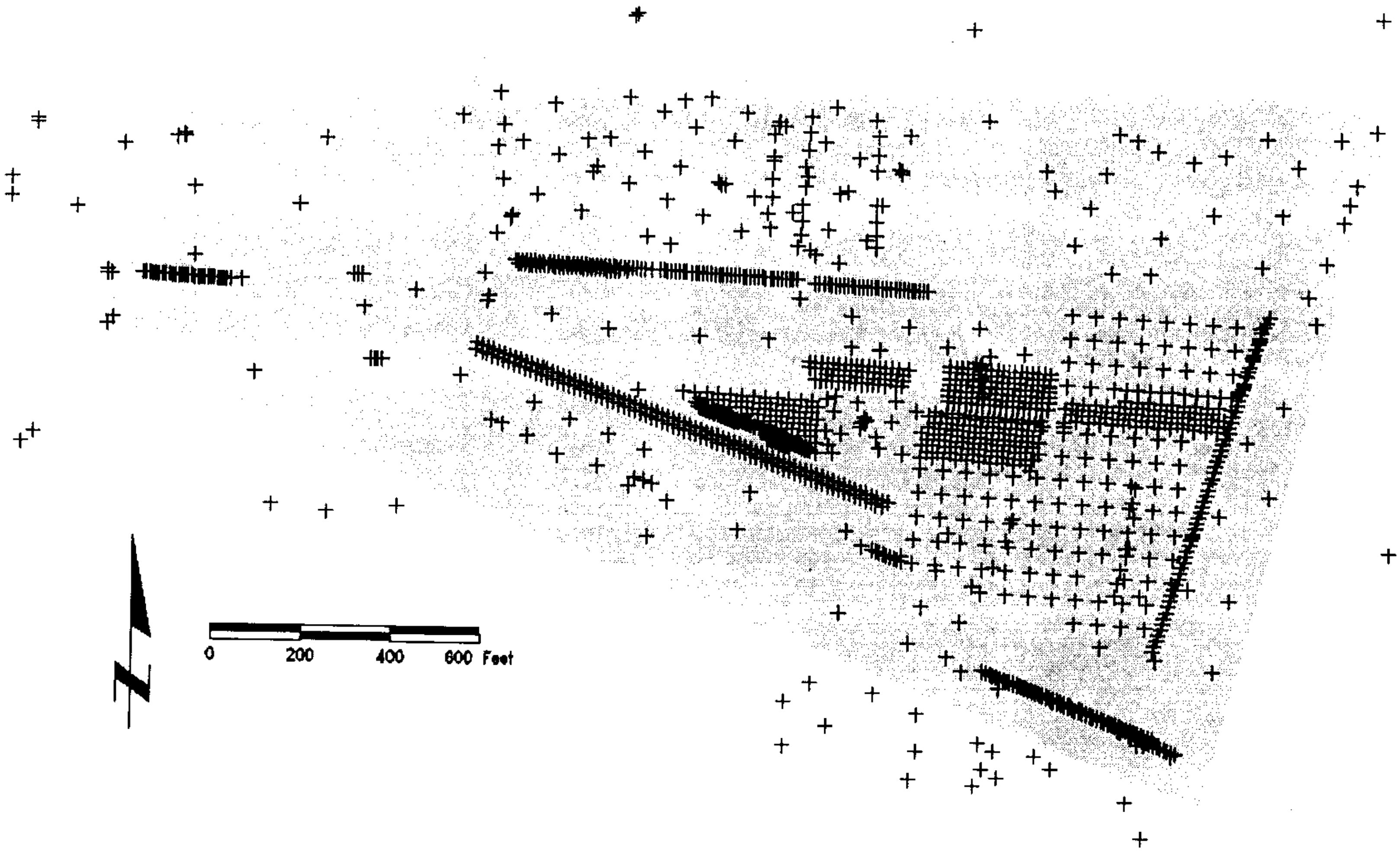


FIGURE 2 Basalt elevation sample points

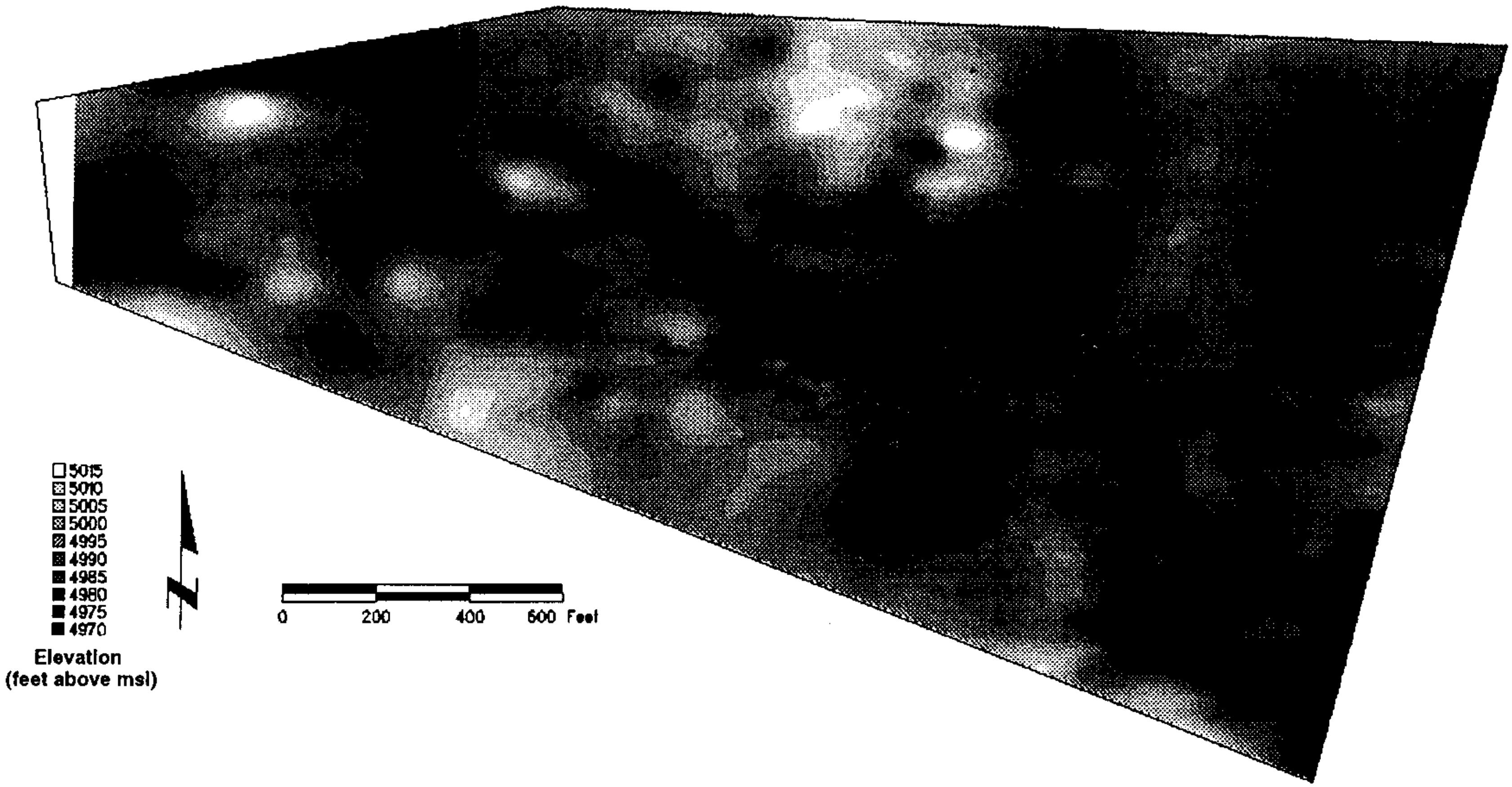


FIGURE 3. Hillshaded sediment/basalt contact surface

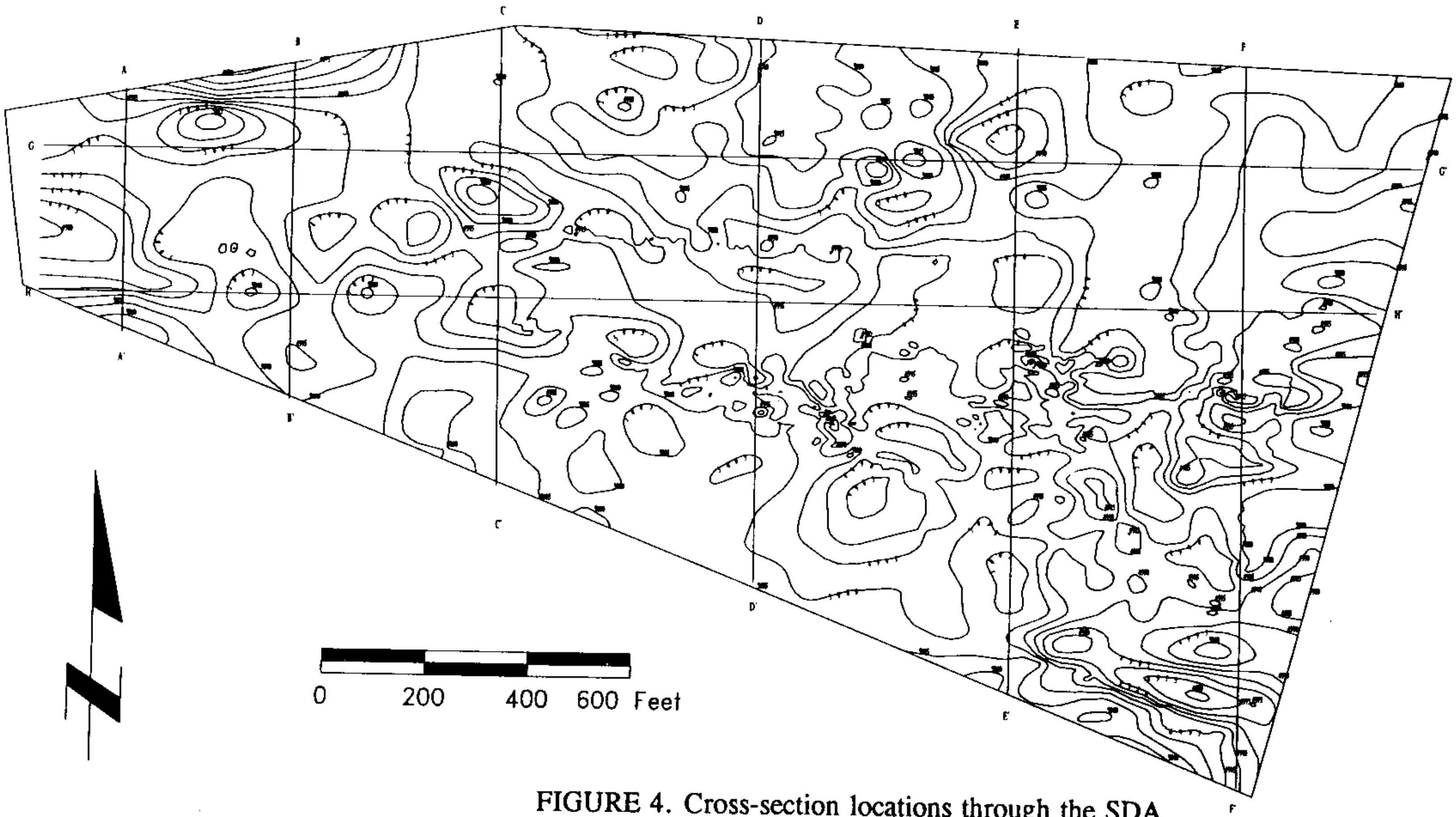


FIGURE 4. Cross-section locations through the SDA

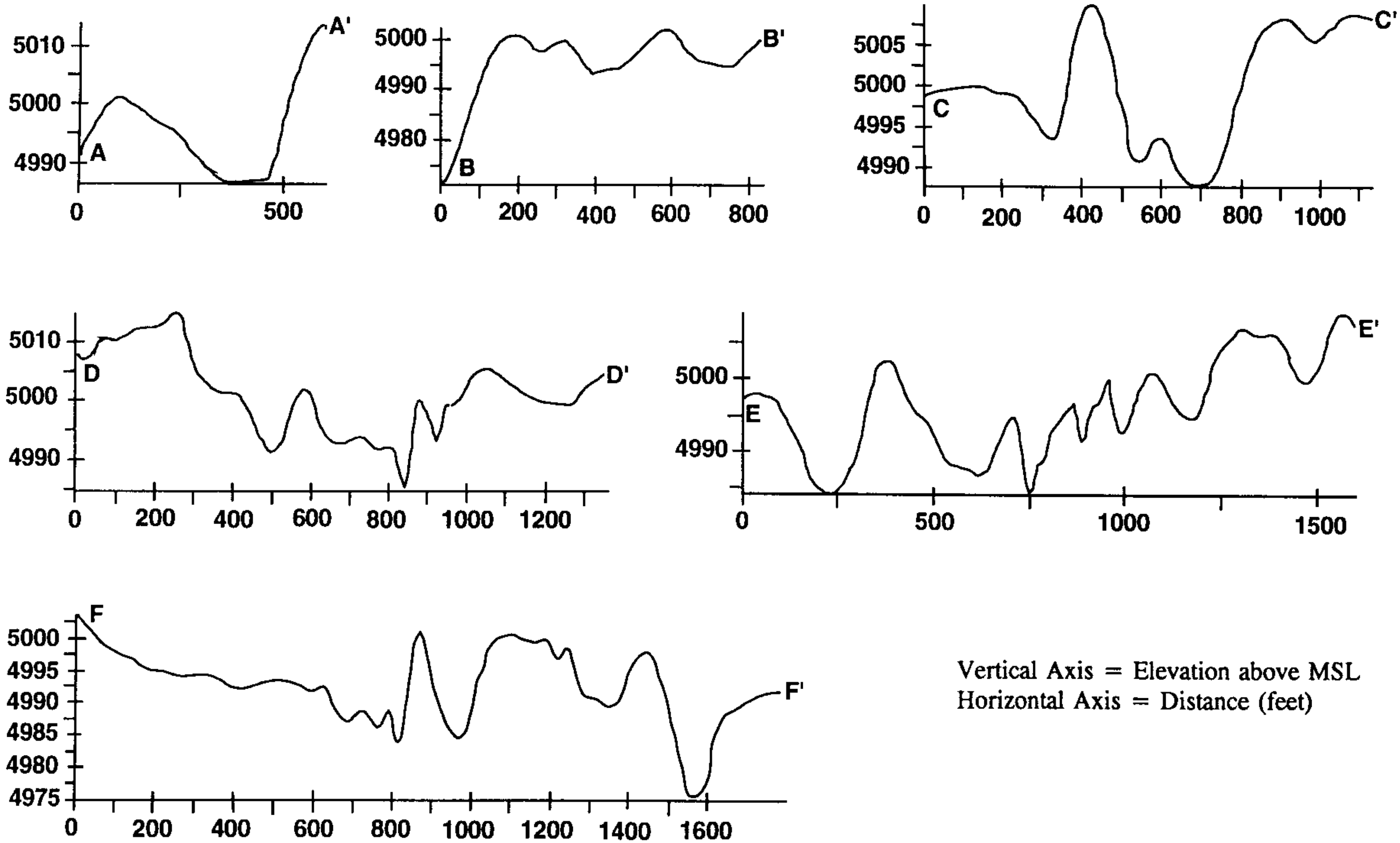


FIGURE 5. Cross-sections A through F depicting the sediment/basalt contact

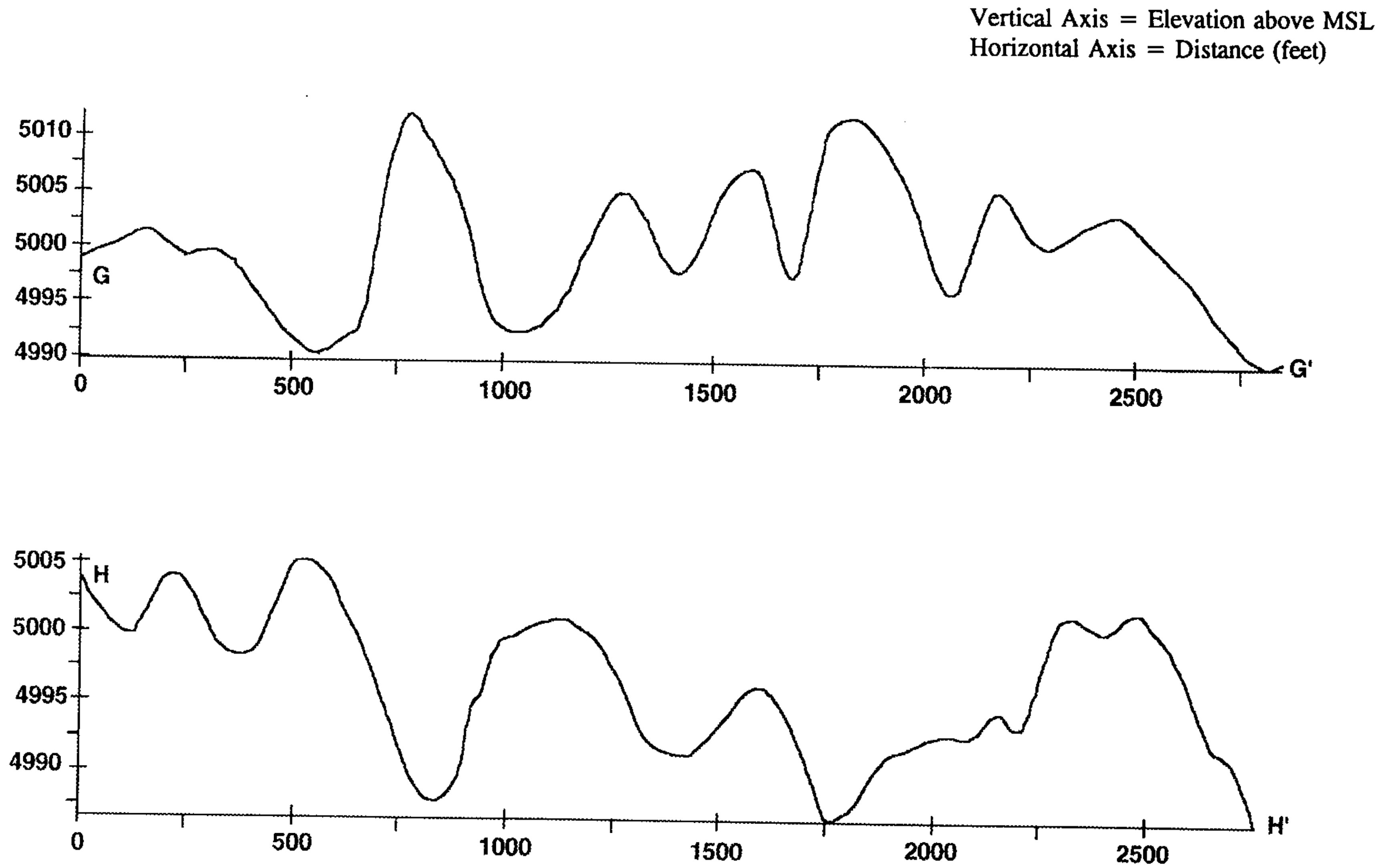


FIGURE 6. Cross-sections G and H depicting the sediment/basalt contact

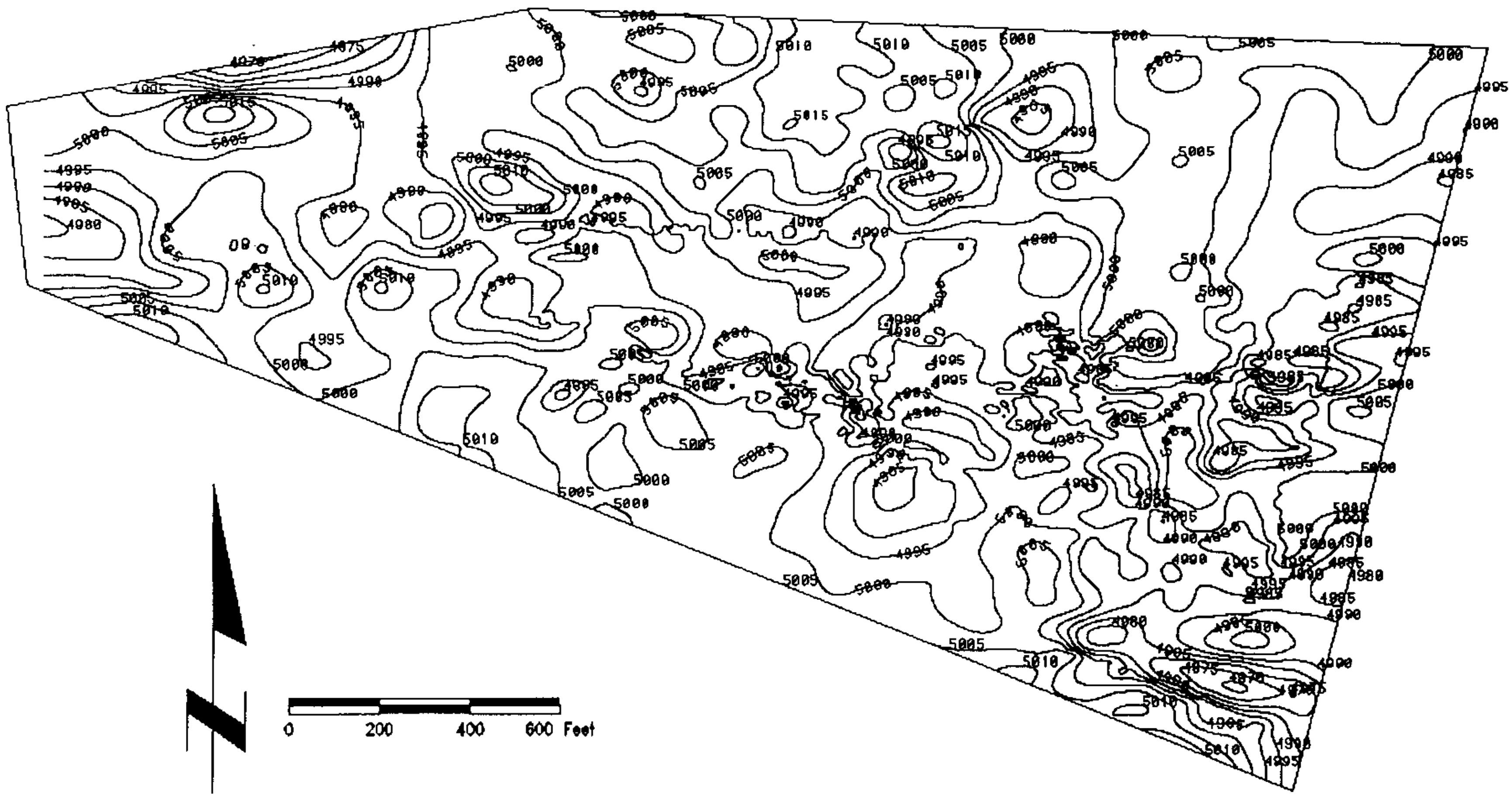


FIGURE 7. Contour map of the sediment/basalt contact below the SDA

3.3 Computing the Land Surface Grid

The land surface grid was computed by clipping the October, 1993 aerially-derived topography (1:2000 scale) to an irregular boundary around the SDA. Figure 8 represents the hillshaded perspective of the resulting gridded surface. Several values contained in this grid are lower or equal to, in elevation, the subsurface basalt grid (Appendix A). These values are located in the "Active Low-Level Waste Disposal Area", within pits 17-20 (located in the eastern portion of the SDA).

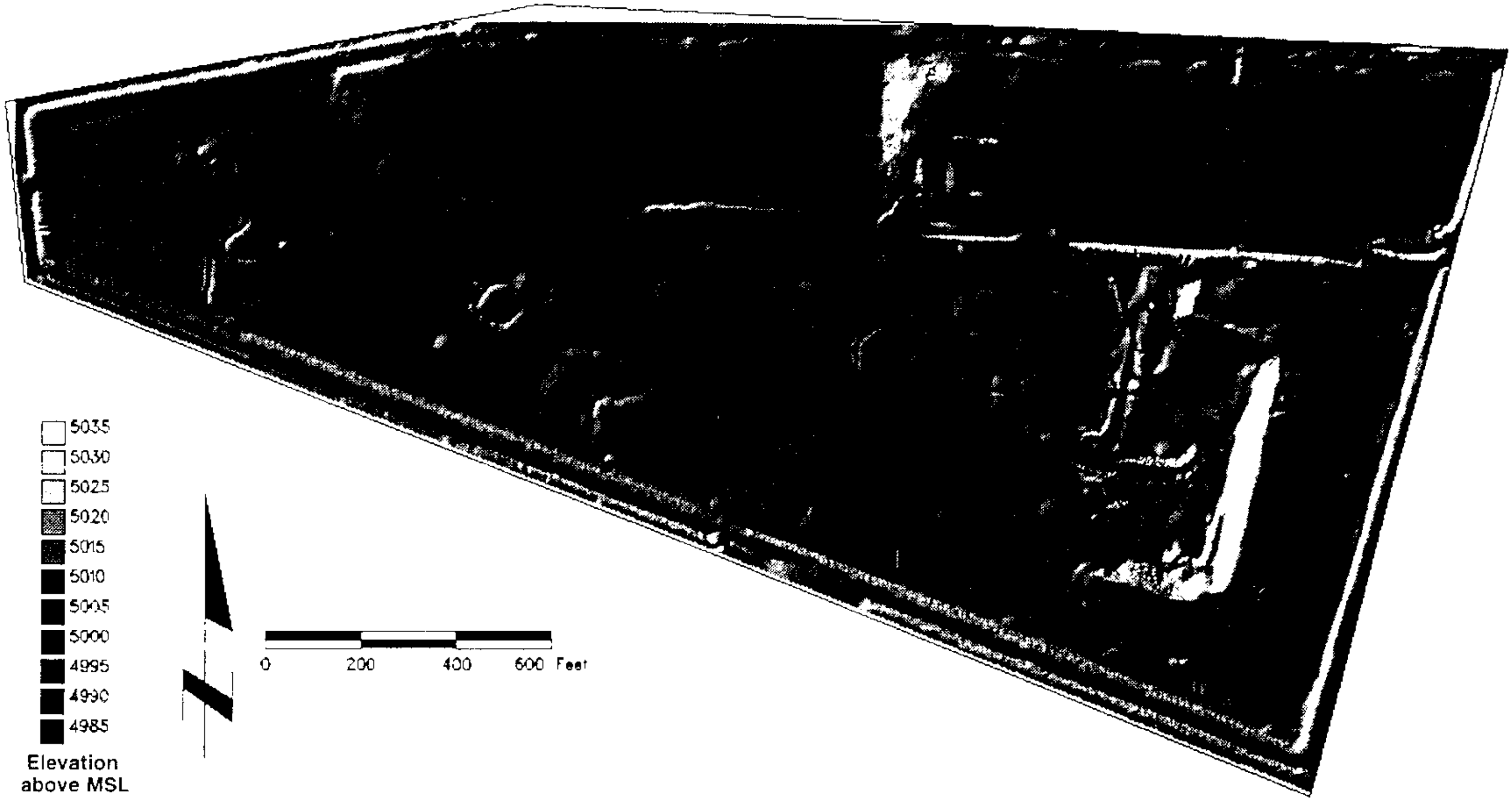
The volume of Pad A (hill located in the top center of Figure 8) was estimated, based on volume calculations from the gridded surface. Based on these calculations, the volume (including soil and buried waste) of Pad A is approximately one million cubic feet (1.2×10^6 cubic feet).

3.4 Calculating the Pit Volumes

Once the gridded land and basalt surfaces were defined, both surfaces were trimmed to the pit boundaries. These surfaces were then subtracted from one another and the remaining grid cells were multiplied by four (the area of an individual cell).

The resulting grid represented a volume surface. Because the splined subsurface was higher in places than the topographic surface (in the Active Low-Level Waste Disposal Area), all negative volume cells were set to zero before proceeding.

The final step in calculating the volume of the pits was to sum all cells with a positive volume. The resulting calculation yielded, for all pits, a volume of approximately 15.3×10^6 cubic feet. This number represents the soil and buried waste volume from land surface to the top of the basalt within all pit boundaries. Additional volume calculations were performed for each individual pit. The resulting volumes are assembled in Table 1.



(Shadows are shown on the above illustration, as well as shades corresponding to elevation change.)

FIGURE 8. Hillshaded perspective of the SDA land surface elevation

Table 1: Volumes of pit areas at the Subsurface Disposal Area, RWMC. (See Figure 9 for the location of the pit corresponding to the assigned number in column 1)

Pit Name	Pit Volume (ft^3)	Min. Depth (ft)	Max. Depth (ft)	Mean Depth (ft)	Std. Dev. (ft)
Pit 2	2.1×10^6	6.7	26.4	18.3	3.6
Pit 3	4.8×10^5	5.5	17.8	11.6	2.6
Pad A	1.2×10^6	0	40.6	15.4	9.1
Pit 5A	5.3×10^5	2.6	24.6	11.1	5.2
Pit 5	9.3×10^5	6.0	24.3	14.0	3.2
Pit 8	1.8×10^5	1.0	10.2	5.8	1.8
Pit 9	7.3×10^5	8.0	23.1	16.0	4.1
Pit 14	5.9×10^5	3.7	26.4	14.4	5.7
Pit 15	1.8×10^6	11.3	35.4	24.1	4.5
Pit 16	5.3×10^5	0	35.3	21.8	5.7
Pit 17	4.6×10^5	0	25.3	7.2	14.1
Pit 18	*	*	*	*	*
Pit 19	*	*	*	*	*
Pit 20	*	*	*	*	*
Pit 6	1.1×10^6	5.3	25.4	19.4	4.3
Pit 11	5.2×10^5	7.9	36.2	21.1	5.0
Pit 12	6.4×10^5	10.5	31.9	21.3	4.0
Pit 4	1.9×10^6	10.1	26.1	17.6	3.6
Pit 10	2.1×10^6	2.4	33.9	19.1	5.9
Acid Pit	3.7×10^5	14.0	21.6	17.5	1.5
Pit 13	4.1×10^5	13.1	29.3	21.5	4.0

* Pits presently open for waste disposal

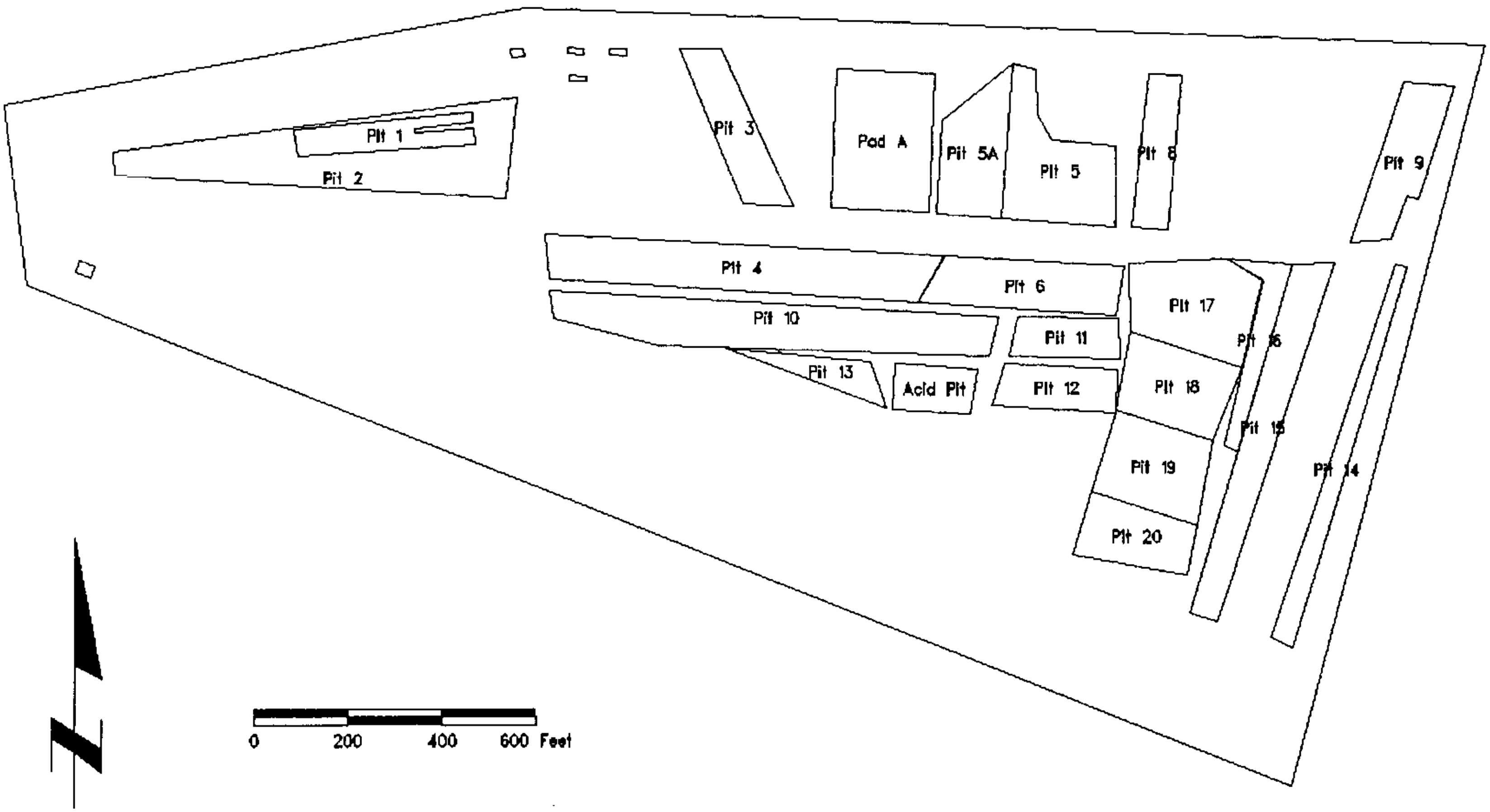


FIGURE 9. Location of Pit areas used in soil volume calculations

3.5 Calculating the Trench Volumes

Because the trench boundary locations are questionable and in very close proximity to one another (Yokuda, 1992), determination of individual trench volumes were not calculated. Instead, the trenches were blocked together in a network and these individual areas were calculated for a soil volume (Figure 10). Therefore, these volumes are overestimated due to the inclusion of trench walls (separating each trench) and waste within the trenches were contained in the calculations. The logic for calculating the soil volume of these close-spaced trenches is that retrieval will most likely involve removal of soil in an area, rather than specifically where an individual trench was originally dug.

The trench area(s) grid was multiplied by the topographic surface and the underlying splined surface (basalt) to produce the trench top and bottom. As in the pit volume calculations, the volume was calculated by subtracting the top surface from the bedrock surface and multiplying the difference by the area of each cell (four square feet). The total volume (including soil and waste) of all the trench "network" areas is 16.7×10^6 cubic feet. The trench area volumes are defined individually in Table 2.

Table 2: Volumes and depths of trench areas at the Subsurface Disposal Area, RWMC. (See Figure 10 for location of the trench areas corresponding to the trench number in column 1).

Trench Area Name	Trench Volume (ft^3)	Min. Depth (ft)	Max. Depth (ft)	Mean Depth (ft)	Std. Dev. (ft)
Trench 1	1.5×10^6	0	31.2	14.7	7.3
Trench 2	9.7×10^4	7.8	20.4	15.1	3.4
Trench 3	1.7×10^5	7.2	23.3	16.1	5.3
Trench 4	3.8×10^5	6.2	26.5	17.8	3.7
Trench 5	1.9×10^6	4.1	29.5	17.7	5.3
Trench 6	3.5×10^6	3.6	39.2	19.7	9.4
Trench 7	1.4×10^6	0	25.7	11.0	5.5
Trench 8	2.4×10^6	2.1	38.4	16.3	8.8
Trench 9	1.1×10^5	6.5	27.3	18.0	3.6
Trench 10	5.3×10^6	6.7	29.8	16.5	5.7

See Appendix C for the specific trenches and soil vault rows included in each trench area

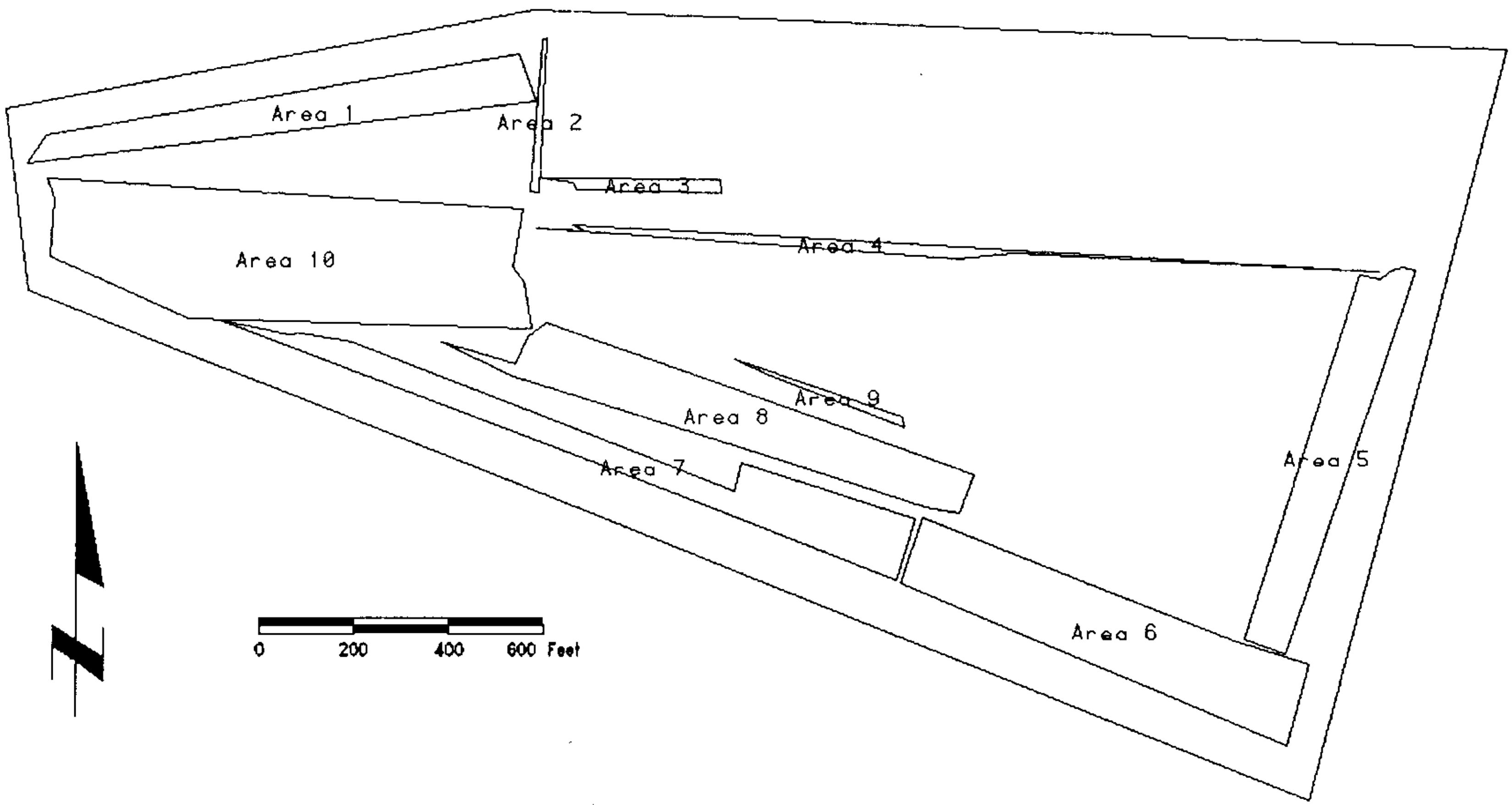


FIGURE 10. Location of Trench areas used in soil volume calculations

4.0 CONCLUSION AND RECOMMENDATIONS

Statistical surface generation techniques were used to construct a contour map of the surficial sediment/basalt contact and to determine soil volumes within pit and trenches in the SDA. Plan view drawings, cross-sections, and tables are used to present this information. This data is presented to provide a data base for future remedial actions at this site. Approximately 1400 elevation data points from published and unpublished reports, maps, and surveyors notes were compiled to generate this report.

The lowest elevation of the surficial sediment/basalt contact is 4970 ft and the greatest is land surface at 5015 ft. In general, an east-west trending depression exists in the central portion of the SDA and bounded by areas of basalt closer to land surface to the north and south.

The trench soil volumes were calculated by grouping close-spaced trenches together and determining the volume of this area. Therefore, these volumes are overestimated due to the inclusion of trench walls (separating each trench) and waste within the trenches were contained in the calculations. The resulting calculations for all trench areas yielded a volume of 16.7×10^6 cubic feet. This number represents the soil volume from land surface to the top of the basalt for all the trench areas.

The total volume of soil for all pits is 15.3×10^6 cubic feet, including the area obtained by waste. The volume of Pad A, from land surface to the top of the mound or hill, is approximately 1.2×10^6 cubic feet. These areas, as well as the trenches, include the volume of buried waste presently at these locations.

The accuracy of pit and trench locations and dimensions are crucial for determining a soil volume above these areas. Much of the data concerning the locations are based on historical records. Without accurate location data these soil volumes could be grossly overestimated. The expense for disposing of large volumes of soil may not be cost effective. For example, Carpenter (1992) indicates that the historical record does not correlate well with the geophysical interpretation of the location of Trench 9. Trench 9 was not observed in the geophysical data. However, it is possible that the geophysical method used could not detect the type of waste disposed of in Trench 9. Carpenter (1992) also states that the location given in the historical data for Pits 1 and 2 in general correlates well with the geophysical data. The uncertainty in the historical record however is plus or minus 30 feet. This number can be confidently reduced to plus or minus 5 feet with the use of geophysical data.

Carpenter (1992) surveyed approximately two-thirds of the pits and trenches within the SDA using geophysical techniques. The pit and trench boundary map for this area, based on the geophysical data, has greatly enhanced our understanding of true pit and trench locations. In some cases the geophysical data support the historical data and greatly reduce the uncertainty assigned to those locations. In other cases, the geophysical data show that the historical data poorly represent the true location of the buried waste. Perhaps the greatest virtue of the geophysical data is that the locations of buried waste can be tied directly to physical measurements rather than historical accounts with uncertainties that cannot be fully understood. It is recommended that the remaining portion of the SDA be surveyed using these geophysical techniques in order to obtain the most accurate location data possible. This is supported by Yokuda's (1992) investigation of the historical records in which she states that the error margins assigned to the coordinates for most of the pits and trenches are large enough that they encompass parts of other pits and trenches in the same area. Before considering action on one pit, trench, or soil vault row, the eventuality that other entities, including unrecorded waste, may inadvertently be disturbed must also be considered.

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